Heavy Element Nuclear Chemistry and Physics
Selected Accomplishments of 2001

- Element 118 cross section limits.

  In the spring of 2001, the $^{208}Pb(^{86}Kr, n)^{293}118$ reaction was studied with the Berkeley Gas-filled Separator (BGS) in an attempt to reproduce the reported production of element 118. No element 118 was detected. The upper limit on the element 118 production cross section is less than 2 picobarns over a wide range of ^{86}Kr beam energies and assumed element 118 magnetic rigidities. This limit is significantly lower than that reported for element 118 production in 1999. Re-analysis of the 1999 data showed that the reported element 118 chains are not in the original data files. Appropriate measures have been taken to prevent re-occurrence of the report of incorrect experimental results.

  [Read more about cross section limits for the production of element 118 (PDF)]

- Production of $^{271}110$.

  The BGS was used to study the production of $^{271}110$ via the $^{208}Pb(^{64}Ni, n)$ reaction. Two event chains corresponding to the production and decay of $^{271}110$ were observed, confirming the GSI discovery of element 110. The decay properties and production cross sections for $^{271}110$ were well reproduced. These experiments demonstrate the capability of the 88-Inch Cyclotron and Berkeley Gas-filled Separator to perform heavy element experiments with production cross sections as small as a few picobarns.

- First measurement of element 108 chemical properties.

  The CTS and a similar device from PSI (Switzerland) were used in collaborative experiments at GSI (Germany) to make the first measurements of the chemical properties of element 108. Seven atoms of element 108 (hassium, Hs), were detected, in the form of the tetroxide, HsO_4. The adsorption enthalpy of HsO_4 on SiO_2 was determined to be (-46 ± 3) kJ mol^{-1}. From this value the enthalpy of sublimation could be estimated as (58 ± 16) kJ mol^{-1}. HsO_4 was found to be slightly less volatile than OsO_4, its lighter homologue, as expected for the last member of group 8 of the periodic table.

  [Read more about the first measurement of the chemical properties of element 108 (PDF)]

- Development of a Cryogenic Thermochromatographic System.

  A Cryogenic Thermochromatographic System (CTS) was built to study the volatility of the tetroxide of element 108 (hassium, Hs).

This chemical separation system was coupled to the BGS, and tested with OsO_4, the periodic table homologue of HsO_4. This novel technique uses a series of P-I-N diodes, arranged along a temperature gradient, as both the gas-phase chromatography surface and the detector system, resulting in a significant increase in experimental sensitivity.

[Read more about the CTS (PDF)]

- Coupling of BGS with chemical separation systems.

  Together with visiting scientists from the University of Oslo, the SISAK chemical separator system was coupled with the BGS. A proof-of principle experiment was performed, where 4.5-second ^{257}Rf was produced in the $^{208}Pb(^{50}Ti, n)$ reaction. After separation from other reaction products with the BGS, the Rf atoms were transported to the SISAK on-line liquid-liquid extraction system. After chemical separation of ^{257}Rf by continuous liquid-liquid extraction in SISAK, the alpha decay of ^{257}Rf, and the short-lived ^{253}No and ^{249}Fm daughters were measured by liquid scintillation pulse height spectroscopy. These experiments demonstrated an important new capability in transactinide chemical separations, where well-understood liquid-liquid extraction techniques can be used to study chemical properties of transactinide isotopes with half-lives of only seconds, and production rates of only a few atoms per hour.

  [Read more about SISAK (PDF)]

- Electron capture-delayed fission in Gammasphere.

  The electron-capture-delayed fission of ^{232}Am was studied with the Gammasphere detector array. 1.3-minute ^{232}Am was produced in a high-intensity ^{3}He irradiation of a stack of 10 ^{237}Np targets in our actinide target irradiation facility. The ^{232}Am products were transported with a gas-jet to a sample changer system situated at the center of the Gammasphere array. X-rays, gamma rays, and fission fragments from the electron-capture-delayed fission of ^{232}Am were recorded. The data are presently being analyzed in a search for gamma rays within the second well of the ^{232}Pu nuclear potential. These data will be used for determination of the energy and deformation of the ^{232}Pu fission isomer.

  [Read more about ECDF using Gammasphere (PDF)]

- Six publications in refereed journals, one Ph.D. thesis, and twenty invited talks during the last year.